

REPORT DOCUMENTATION PAGE

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1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (From - To)		
	Technical Papers			
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<p><i>Please see attached</i></p>		5b. GRANT NUMBER		
		5c. PROGRAM ELEMENT NUMBER		
		5d. PROJECT NUMBER		
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		<i>M162</i>		
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		<i>346120</i>		
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<p>Air Force Research Laboratory (AFMC) AFRL/PRS 5 Pollux Drive Edwards AFB CA 93524-7048</p>			11. SPONSOR/MONITOR'S NUMBER(S)	
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Unclassified	Unclassified	Unclassified	(661) 275-5015	

MEMORANDUM FOR PRS (In-House Publication)

GD

FROM: PROI (STINFO)

22 May 2002

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-VG-2002-130**
C.T. Liu (PRSM); F.P. Chiang (NYSU), "Investigating the Deformation and Failure Mechanisms in Bi-Material Systems Under Tension"

ASME Winter Meeting (Statement A)
(Blacksburg, VA, 24-28 June 2002) (Deadline = 23 June 2002)

1. This request has been reviewed by the Foreign Disclosure Office for: a.) appropriateness of distribution statement, b.) military/national critical technology, c.) export controls or distribution restrictions, d.) appropriateness for release to a foreign nation, and e.) technical sensitivity and/or economic sensitivity.

Comments: _____

Signature _____ Date _____

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Comments: _____

APPROVED/APPROVED AS AMENDED/DISAPPROVED

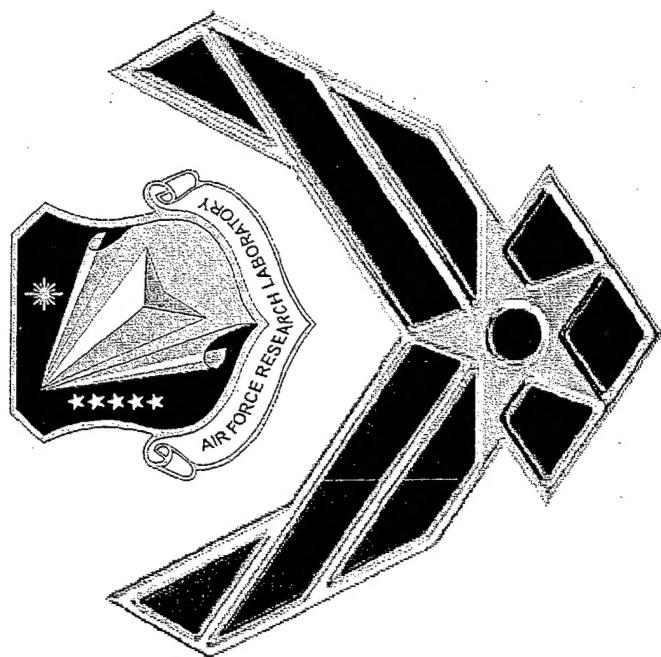
PHILIP A. KESSEL

Date

Technical Advisor

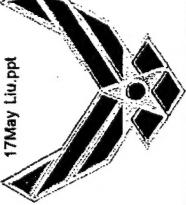
Space and Missile Propulsion Division

Investigating the Deformation and Failure Mechanisms in Bi- Material Systems under Tension



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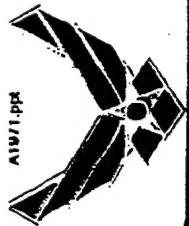
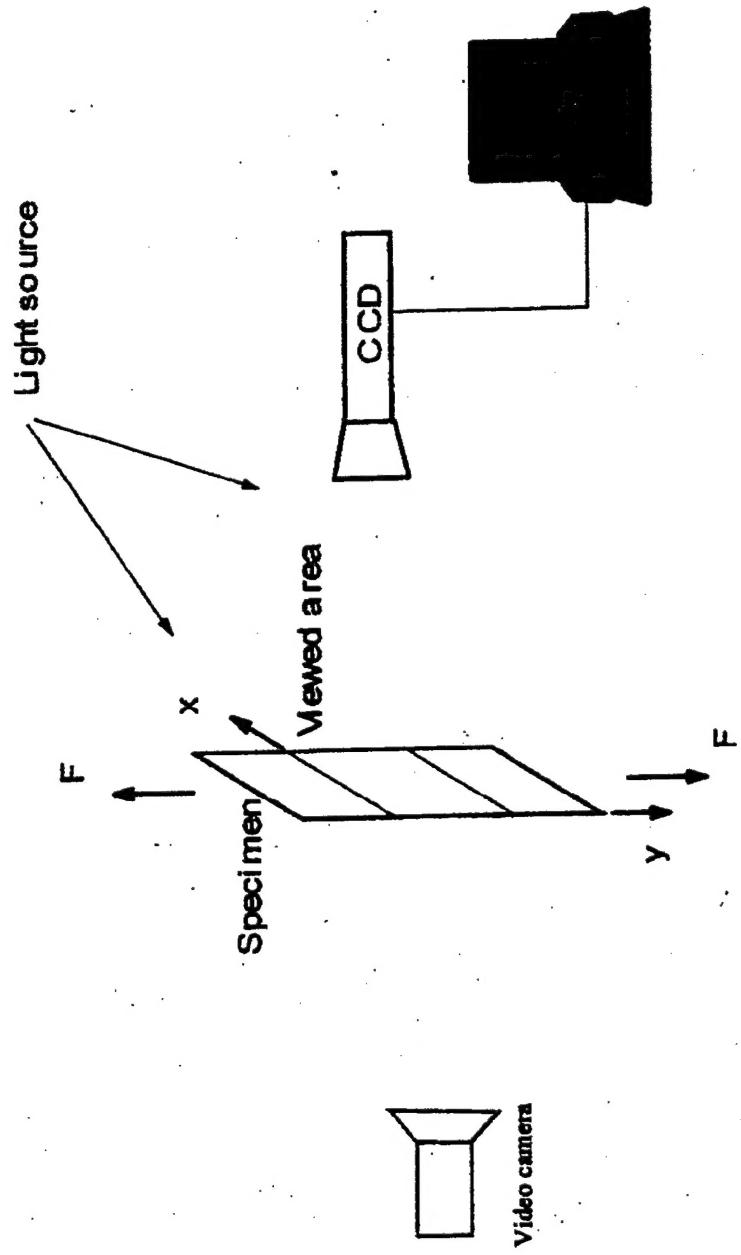
Fu-Pen Chiang
Department of Mechanical Engineering
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Stony Brook, N.Y. 11790



Objectives

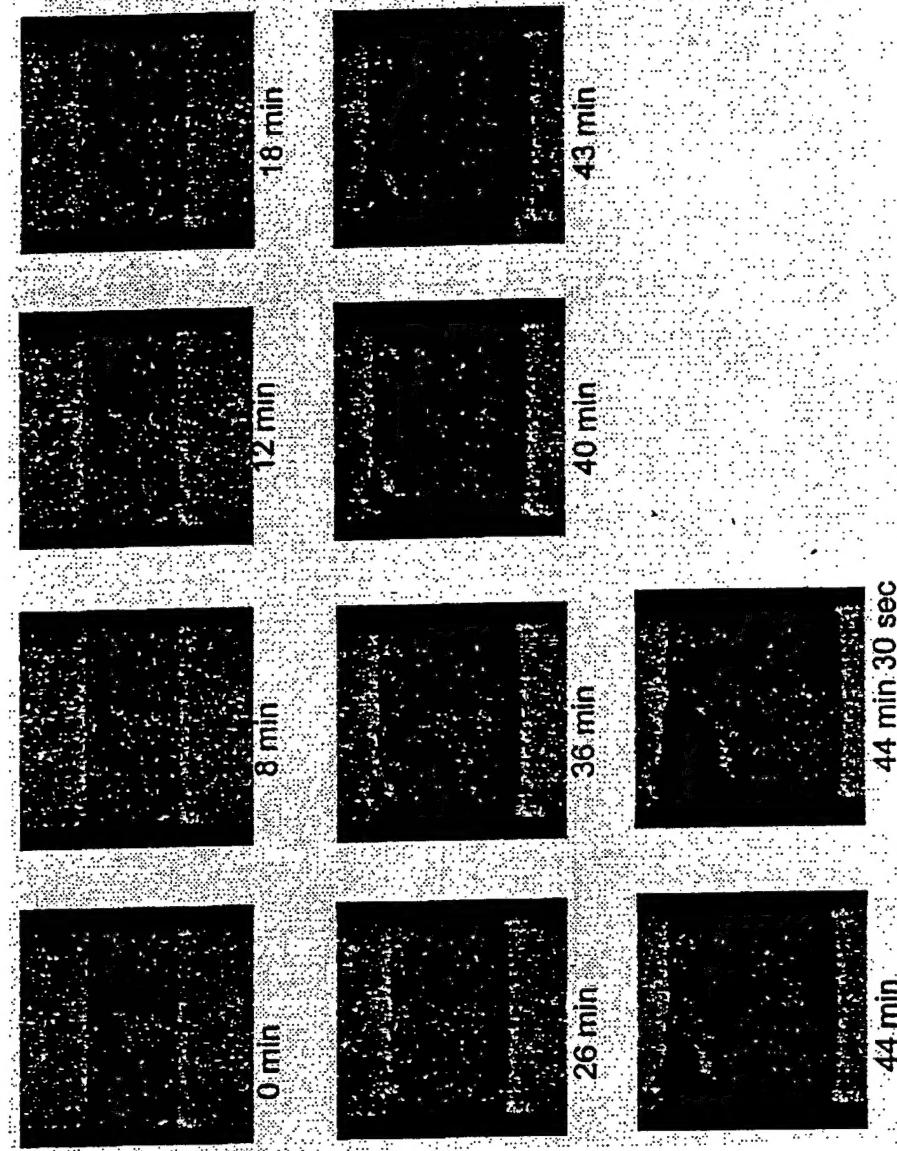
- ¥ Investigate the Local Strain Distribution and Failure Mode in a Bi-Material Bonded
 - Specimens under a Constant Displacement Rate Condition.
- * Displacement Rate = 0.02 in/min
- ¥ Determine the Critical Strain for Debond at the Interface between the Two Materials.

Experimental Set-Up



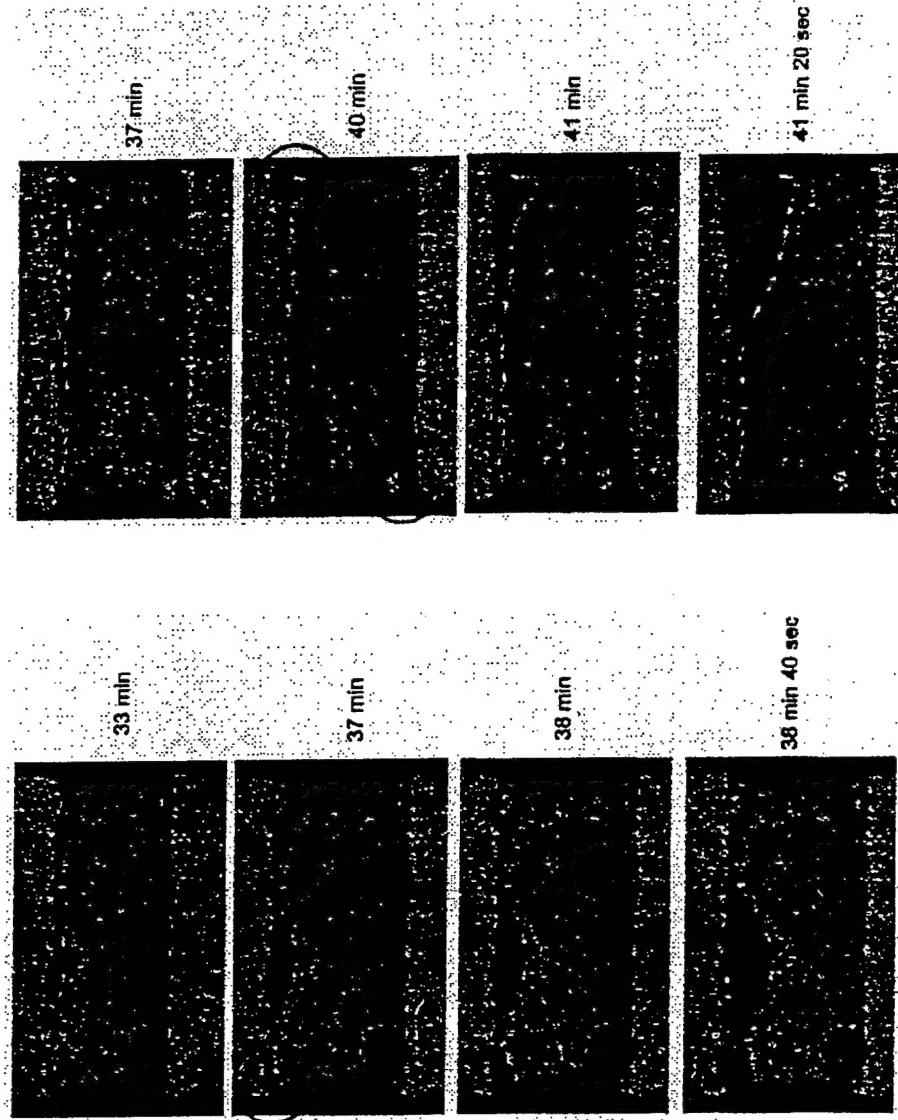
The Mechanism of Debonding

Thickness to Width Ratio: 1:1:00



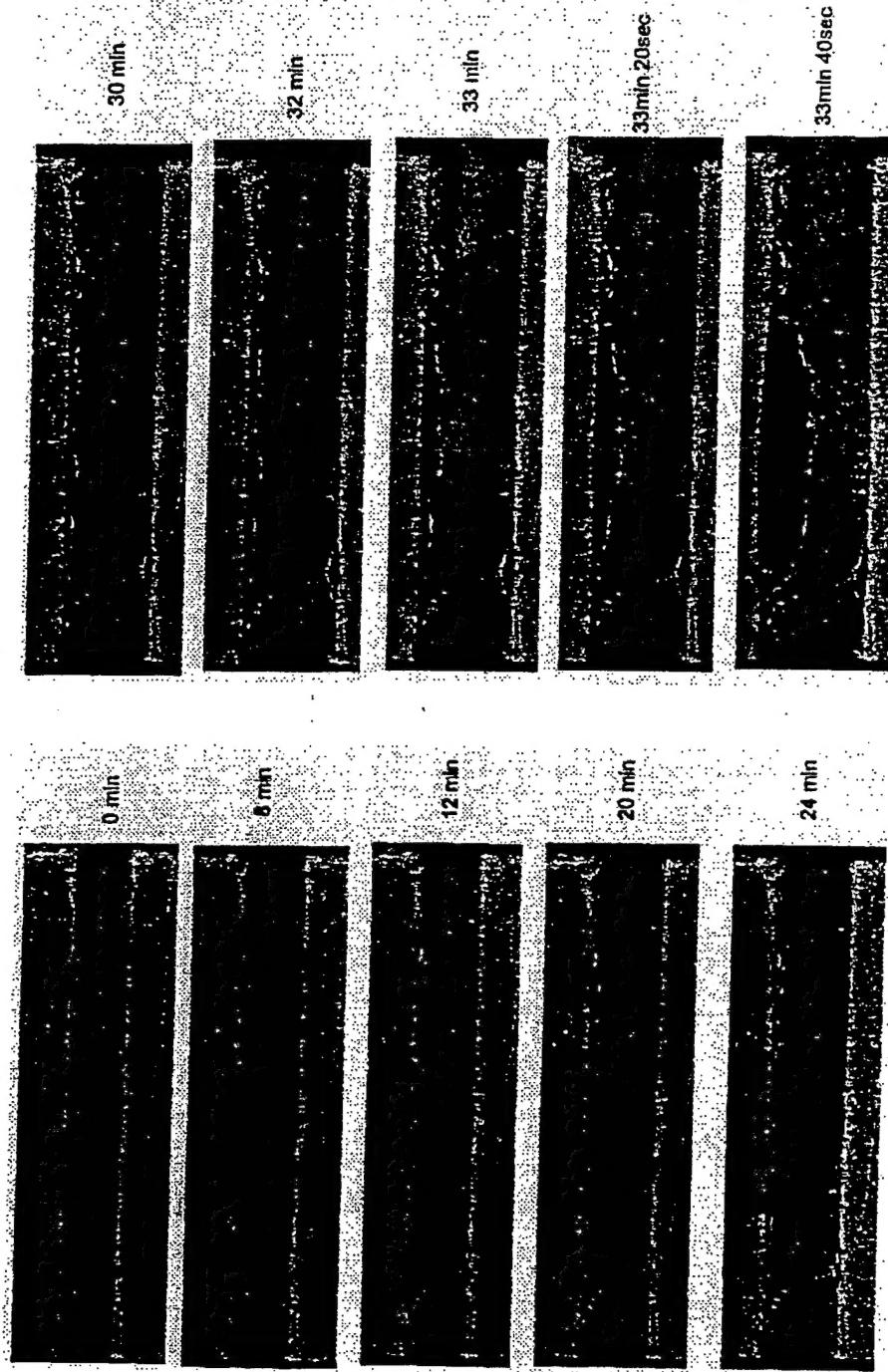
The Mechanism of Debonding

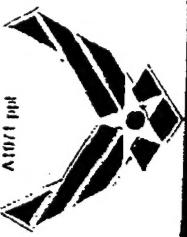
Thickness to Width Ratio: 1:2.25



The Mechanism of Debonding

Thickness to Width Ratio: 1:5.00





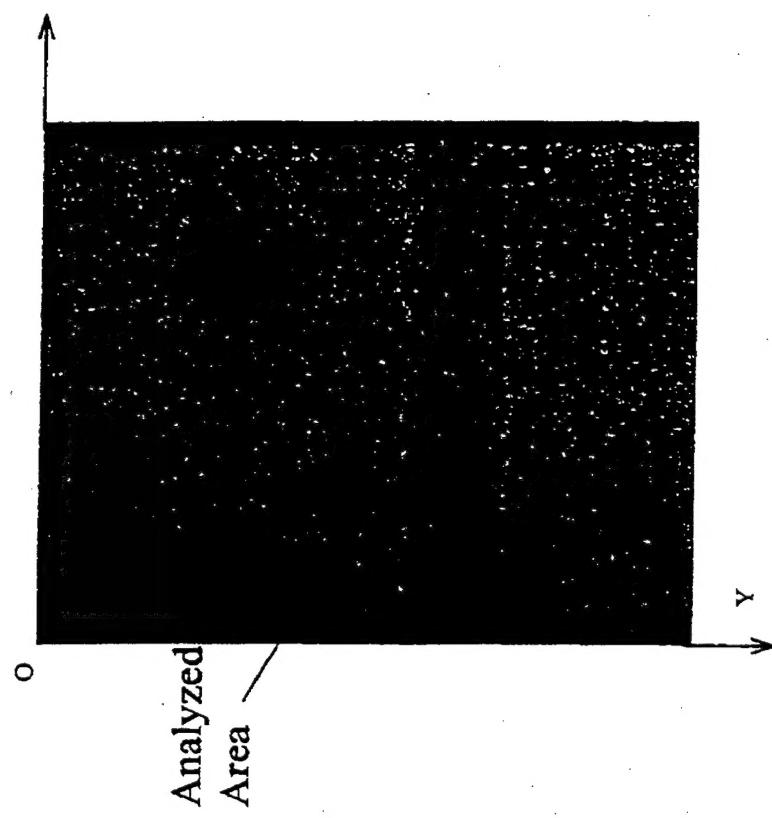
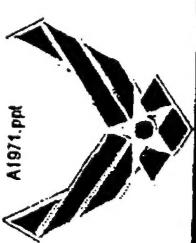
Altair 1 ppt

The Debonding Modes

Size: t x w (in)	Ratio: t:w	Number of Specimens	Debond at center		Debond at corner
			h~4 in	h~0.1 in	
0.2 x 1	1:5	2	2	0	0
0.2 x 0.5	1:2.5	3	3	0	0
0.2 x 0.4	1:2	4	1	3	3
0.2 x 0.2	1:1	2	0	2	2

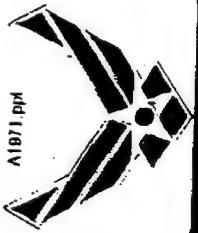
Critical ratio: $\sim 1:2.25$; either mode may prevail

Analysis of Deformation

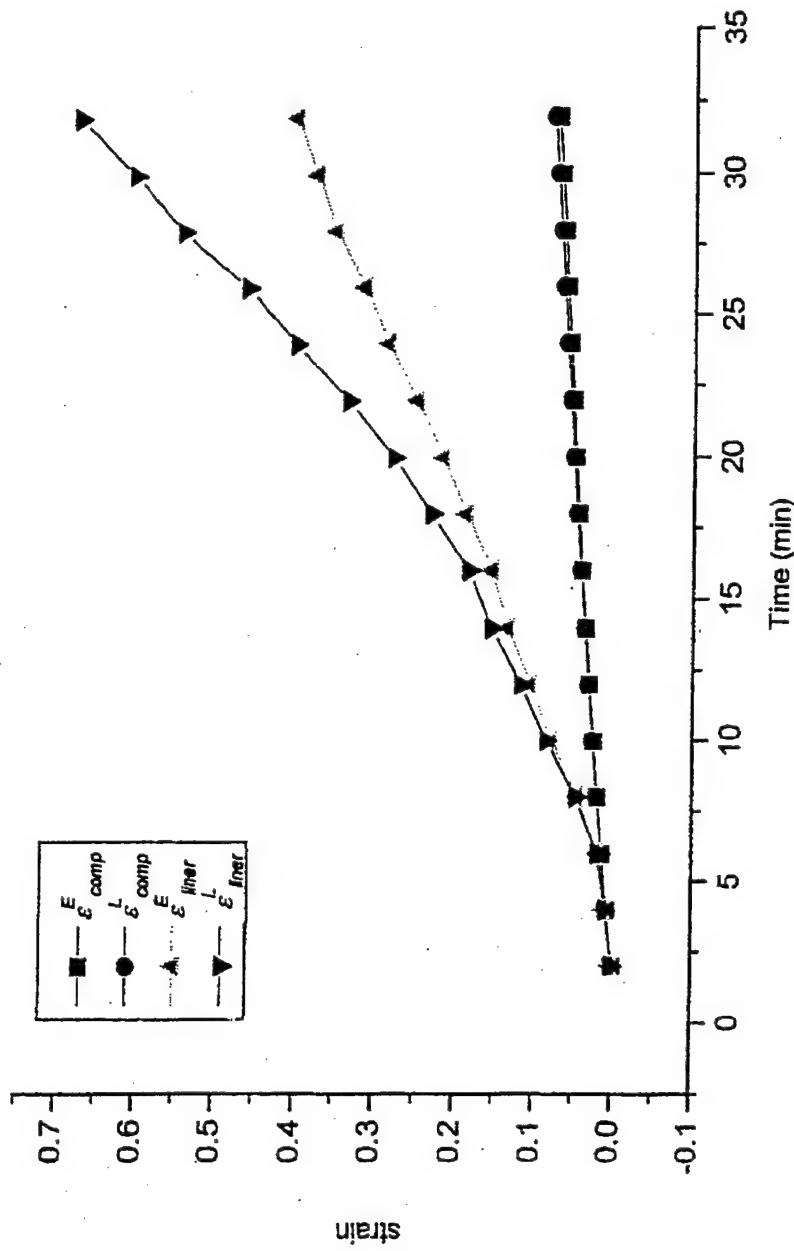




Average Strain Versus Force Curves



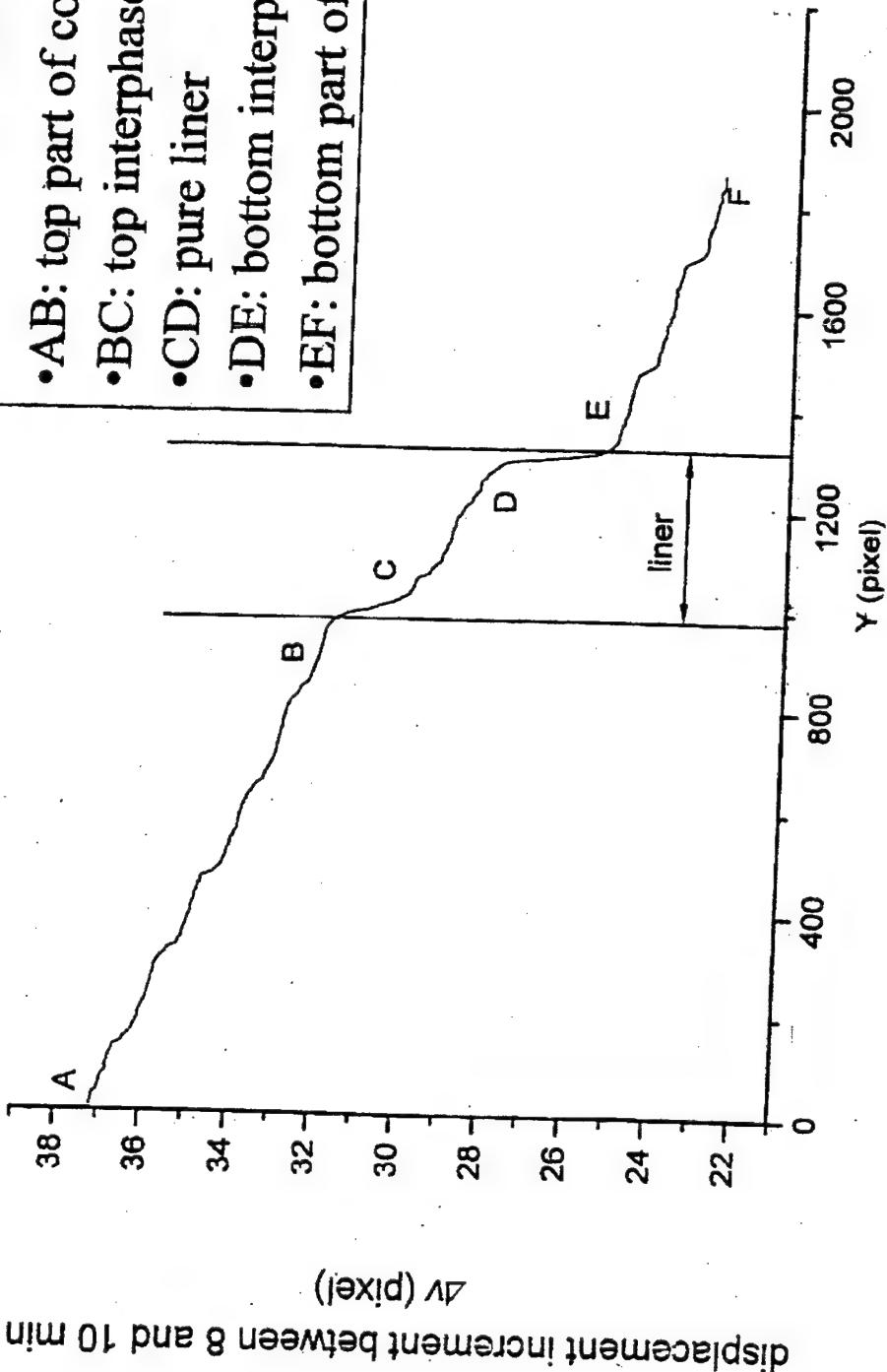
Thickness to Width Ratio: 1:5.00



Displacement Increment Distribution along Y Direction

Five linear sections:

- AB: top part of composite
- BC: top interphase
- CD: pure liner
- DE: bottom interphase
- EF: bottom part of composite

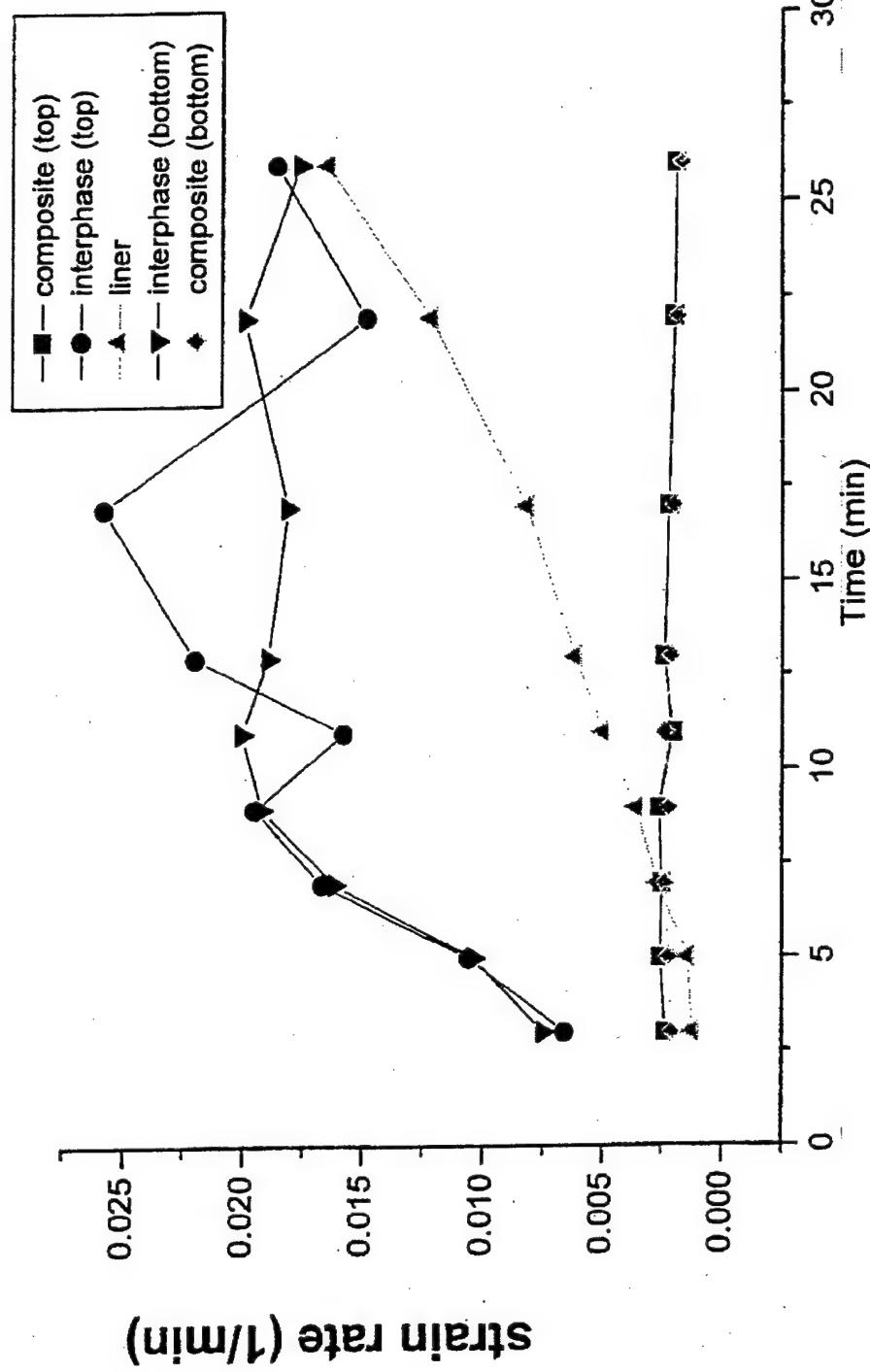


displacement increment between 8 and 10 min



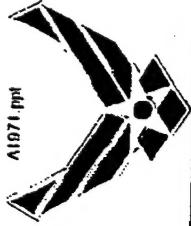
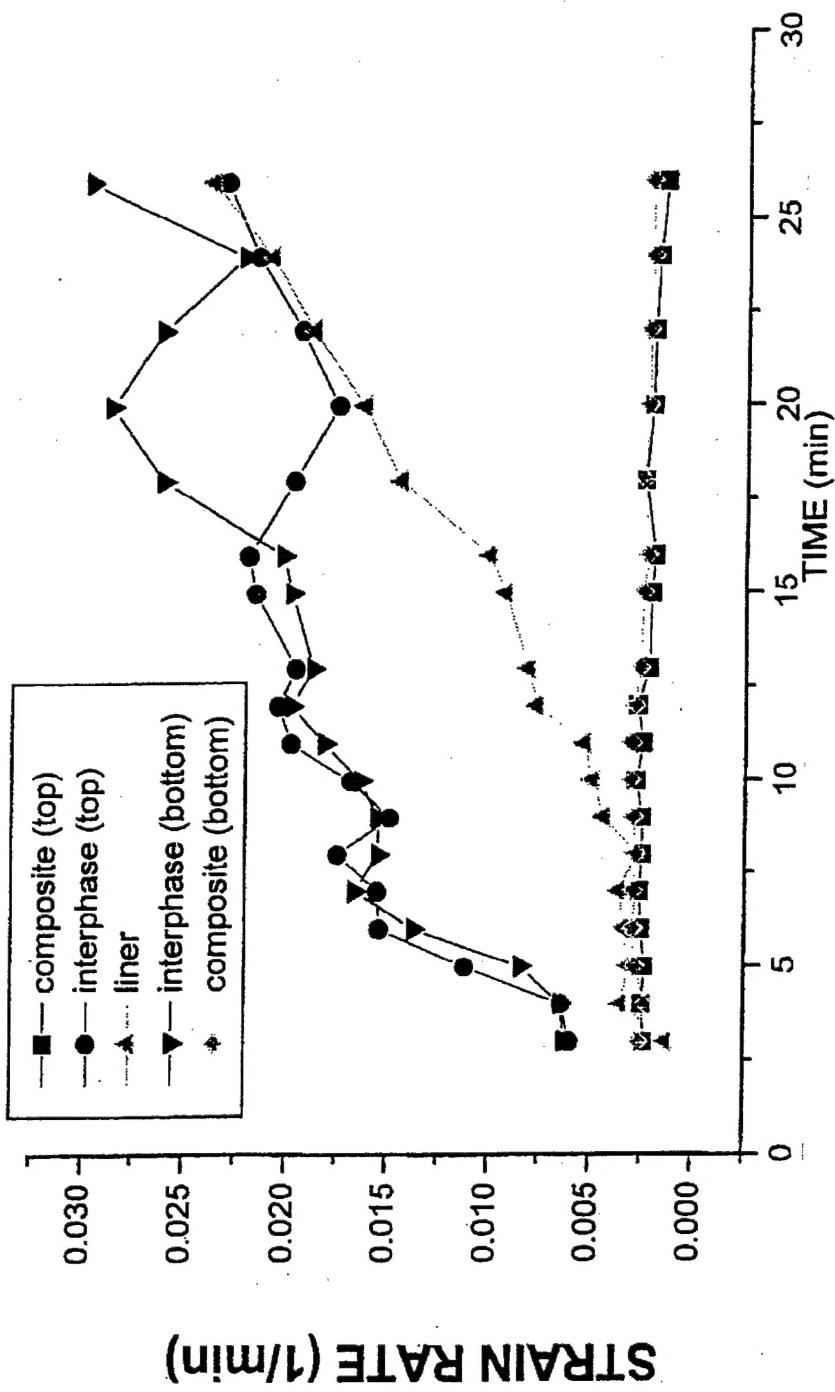
Strain Rate versus Time Curves

Thickness to Width Ratio: 1:2.25

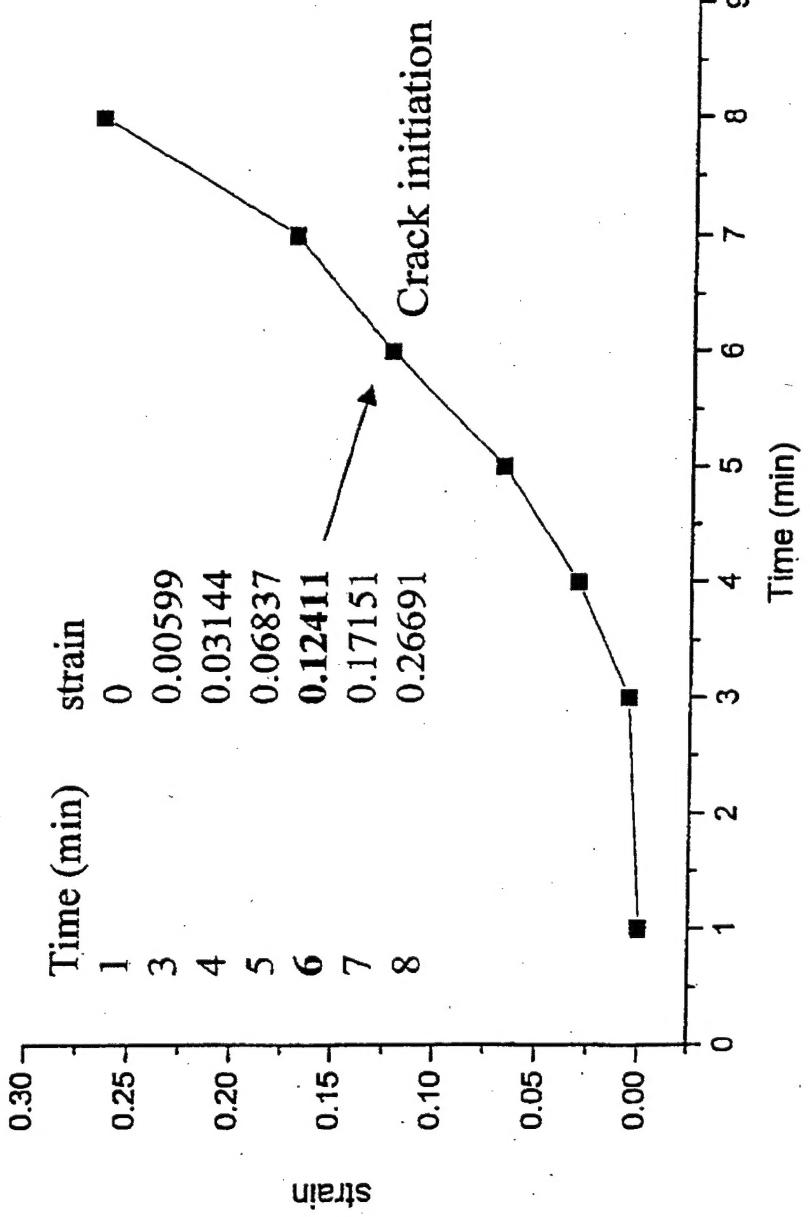


Strain Rate versus Time Curves

Thickness to Width Ratio: 1:5.00



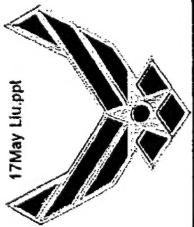
The Time History of Local Strain near Interface



Summary of Debonding Initiation Strain

Specimen #	Size: t x w (in)	Ratio: t:w	Crack initiation strain
K	0.2 x 1	1:5	0.12
n	0.2 x 0.5	1:2.5	0.14
w	0.2 x 0.45	1:2.25	0.13
o	0.2 x 0.2	1:1	0.13

Conclusions



- ¥ The Failure location depends on the geometry of the specimen.
- ¥ There are interphase regions near the interfaces of the specimen.
- ¥ The strain rates in the rubber layer and the interface region change with time.
- ¥ The strain rate in the interphase region is significant higher than that in the rubber and the composite layers.
- ¥ The average critical local debond strain is 13%, which is independent of specimen geometry.